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Apparatus to automatically check the lighting distribution in an automobile headlight

2946561
R. 5876

10-29-1979 St/W1

ROBERT BOSCH GMBH, 7000 Stuttgart 1

Claims

1. An apparatus to check the light distribution of a movable suspended automobile headlight using a television measuring system characterized by the fact that in addition to a microcomputer (4), a computer-controlled digital video signal evaluation circuit (5) is provided which positions the high-beam maximum and the light-darkness boundary produced by the headlight against two position-calibration lamps (13) located on a reflecting projection screen (12) and transfers this positioning information to a monitor (2). It is further characterized by a positioning apparatus (22) being provided with which the headlight (23) can be tilted to prescribed positions, and many photo elements (15), each assigned to an individual measurement point, are arranged on the projection screen (12), all with prescribed photoelectric limits.

2. An apparatus according to Claim 1 characterized by the fact that the horizontal and vertical development of the light-darkness boundary is measurable along the light gradients.

3. An apparatus according to Claim 1 or 2, characterized by the fact that the rows of the measuring television system are perpendicular to the boundary between light and darkness.

4. An apparatus according to one of Claims 1 through 3, characterized by the fact that the photo elements (15) have standard calibration curves.

5. An apparatus according to one of Claims 1 through 5, characterized by the fact that the measured values detected by the photo elements (15) are compared to desired values in the microcomputer (4), evaluated and printed.

6. An apparatus according to Claim 1, characterized by the fact that the digital video signal evaluation circuit (5) includes a random access memory (RAM) (56), an adder (57), an address counter (54), a multiplexer (55) and at least two comparators (510) to discriminate gray video signals. It is further characterized by the fact that the comparators (51) are sequenced by the multiplexer (55) through the address counter (54) as the brightness increases, and that the number of pixels in a row of the video signal can be intermediately stored in the random access memory (56) up to a certain gray value, said memory being connected to the microcomputer (4) through a data/address bus (8).

7. An apparatus according to Claim 6, characterized by the fact that the number and gradation of the gray values of the video signal can be predetermined.

2946561
R. 5876

8. An apparatus according to one of Claims 6 or 7, characterized by the fact that the address counter (54) and the microcomputer (4) can be reset by the row-synchronization pulse (60) of the television system.

9. An apparatus according to one of Claims 6 through 8, characterized by the fact that a RAM (56) with at least two memory blocks is provided with which the assignment of the addresses can be exchanged.

10. An apparatus according to one of Claims 6 through 9, characterized by the fact that the assignment of blocks to the addresses of the random access memory (56) can be controlled by the row-synchronization pulse (60).

11. An apparatus according to one of Claims 6 through 10, characterized by the fact that the data from the previous row of the video signal stored in a block of the RAM (56) are read out by the microcomputer (4) and stored in the next row.

12. An apparatus according to one of Claims 6 through 11, characterized by the fact that the address counter (54) can be switched using a gate switch (54) operated as an AND-gate to which the output of the multiplexer (55) and the pixel clock signal (52) of the television system are connected.

13. An apparatus according to one of Claims 6 through 12, characterized by the fact that to detect the decrease in brightness, a reversing circuit (62) is provided that can be triggered by the comparator with the highest threshold limit (517), which changes the assignment of addresses to the rest of the comparators (510) and inverts the output polarity of the multiplexer (55).

14. An apparatus according to one of the previous claims, characterized by the fact that more information can be registered on the monitor (2) by attaching it to the video evaluation circuit (5) using a user interface connected to the microcomputer (4).

2946561
R. 5876

10-29-1979 St/W1

ROBERT BOSCH GMBH, 7000 Stuttgart 1

An apparatus to automatically check the light distribution of an automobile headlight.

State of the technology

The present invention pertains to an apparatus to check the light distribution of an automobile headlight. This type of apparatus should perform this headlight check as precisely, automatically and as fast as possible.

Common test equipment for headlights requires a manual pre-adjustment consisting of the user exactly setting the light-darkness boundary of the headlight between two parallel limiting lines. Along these limiting lines, which must conform to the legally prescribed light-darkness boundary, numerous phototransistors are closely arranged. The geometric form of the light-darkness boundary is then considered acceptable if the upper and lower row of the phototransistors lying in the dark or light region provide signals meeting the prescribed boundary values. However, this type of apparatus cannot detect measured values at prescribed points nor the sharpness of the light-darkness boundary. The only thing that can be determined is that the boundary shape is correct.

Furthermore, measuring television systems with digital screen memory are well-known for a wide variety of purposes: for recognition, measurement or position determination of stationary or moving objects.

H. N‰other, "Elektroniker Nr. 10 und 11" (1975)
R. Kopf; VDI Report No. 265, 59 (1975)
M. Steinwender, "Electronikpraxis" No. 12, 23 (1978)

These devices, which deal with real-time digital-processing video systems, are extraordinarily complicated and expensive. This is a result of the requirements for resolution, memory and data processing speed.

Advantages of the invention

In contrast to the problems mentioned above, the testing apparatus according to the present invention, which has the identifying features of the main claim, allows quick, objective and automatic detection, evaluation, and documentation of the photometric data for the headlight. Also, in addition to the measurement data required to be checked by law, the measuring television system in combination with video signal evaluation enables digital storage of recorded light distribution and evaluation of the light-darkness boundary transition for the headlight. With respect to the latter, it is especially advantageous that the rows of the measuring television system are to be arranged perpendicular to the boundary between light and darkness. In this configuration, practically every row of th video signal contains the development of spatial brightness in the light-darkness boundary, which would only occur in a few rows if this boundary

and television rows were arranged parallel to one another. It is thus possible to use only a half-image, meaning that instead of the normal 625 rows per screen, only 313 are needed. Together with a simple form of gray discrimination of the video signal using comparators with adjustable threshold limits and using linear (serial) storage of the digitized video signal for the number of pixels up to a specific gray value, the entire light distribution of the light-darkness boundary can be determined with good resolution and in a way that fits with the microcomputer's processing. Also, in this way the requirements for memory capacity and especially for system speed are not so high, which is very cost saving.

Illustration

An embodiment example of the invention is shown in the illustration and is explained in more detail in the following description. Figure 1 shows a block diagram of the entire testing apparatus and Figure 9 shows a block diagram of the video signal evaluation circuit.

Description of the Embodiment Example

In the block diagram according to Figure 1, a television camera 1 provides the video signal to a monitor 2 and to a video signal evaluation circuit 5 that is connected to a microcomputer 4 through a data/address bus 8 – shortened to "bus" in further discussion. The microcomputer 4 is further connected to a computer user interface 7. Monitor 2 can also be connected to the video signal evaluation circuit 5 through a signal line 10. A first output driver 11 is connected to the microcomputer 4 through bus 8 and activates the position calibration lamps 13 located on the reflecting projection screen 12. Likewise, many photo elements 15 are arranged on the reflecting projection screen 12 that are connected to the microcomputer 4 through bus 8 using an amplifier 16 with an associated analog-to-digital converter 17. At a second output driver 19, which is also connected through bus 8 to the microcomputer 4, a control unit 20 is connected to adjust the stepper motors 22 which rotatably suspend the headlight 23. The control unit 20 is also connected to a hand operator with an indicating device 27 and is connected to a power source 30 through control line 29 to activate the high beam 25 and low beam 24 of the headlight 23. At bus 8, a printer 33 is connected through an output interface 32.

After the headlight 23 is secured to a device hung on gimbals used to fasten it to the connection points of the respective model, the measurement procedure is started using the hand operator 27. Using microcomputer 4 and the first output driver 11, the position calibration lamps 12 are turned on on the reflecting position screen 12. The television camera 1 pointed at the projection screen 12 records the dark screen with the light positioning lamps 13 (two lamps in this case) and feeds this signal to the video signal evaluation circuit 5. A monitor 2 can be connected directly to the camera parallel to this, showing the recorded picture for control purposes. Monitor 2 can also be connected to the video signal evaluation circuit 5, making it possible to blend more information into the television screen. The television camera 1 is turned 90° compared to normal positioning so that the rows of the television screen are aligned in a vertical direction. The signal evaluation circuit 5 and the microcomputer 4 determine the geometric position of calibration lamps 13. This allows the position of the television camera 1 to be calculated. Using the second output driver 19 and the control unit 20 as well as the power supply 30, the high beam 25 is turned on. The television camera 1 records the screen and the video signal evaluation circuit 5 determines, together with the microcomputer 4, the high beam maximum and its position on the reflecting projection screen 12. The 80% high beam maximum line can be derived from the video signal of the camera. Since the headlight 23 is in it's "un-aligned" position after it is hung,

it will be shining within a certain boundary at some point on the projection screen. In order to exactly determine the light-darkness boundary for the low beam and to save time in the testing process, headlight 23 is tilted to the pre-aligned position corresponding to the coordinates of the high beam maximum while the power supply 30 is switched to low beam 24. This is done by means of the control unit 20 and the stepper motors 22, which turn the headlight 23 horizontally and vertically in its gimbal arrangement.

The television camera 1 records the light distribution and the light-darkness boundary of the low beam 24. The video signal evaluation circuit 5, yet to be described, together with the microcomputer 4, determines the gradient along the vertical rows and the position of the light-darkness boundary transition. From these measured values, the development of the light-darkness boundary can be calculated and, for example, the position of the deviation point at which this boundary deviates upward can be determined. Furthermore, the sharpness of this boundary or its brightness gradient can be evaluated.

Due to the insufficient sensitivity of the television camera 1 in the dark region, the legally prescribed light values at certain prescribed positions cannot be directly determined using the television measuring system. However, the geometric position of the light-darkness boundary is known and stored in the microcomputer 4. Using the second output driver 19 and the control unit 20, the headlight 23 is tilted using the stepper motor 22 such that its dark-light boundary comes to lie in the measured position. In this measured position, the detection of the legally prescribed photometric characteristics is done using photoelements 15 built into the reflecting projection screen 12. These signals are fed to amplifier 16 and digitized in the analog-to-digital converter 17 and finally reported to the microcomputer 4. The microcomputer compares the measured values with the stored limit values that are input into the microcomputer 4 using the computer interface 7. If a measured value is just barely outside the allowable tolerance, headlight 23 is adjusted again by a small amount and the measurement of the legal value is repeated in order to eliminate any errors arising in determining the light-darkness boundary. After switching off the power supply 30, the measured data of the headlight 23 is graded on a good-bad scale and are finally printed out on printer 33 through an output interface 32.

The video signal evaluation circuit 5, shown in more detail in Figure 2, contains a series of comparators 510. The video signal supplied by the television camera 1 is connected to the non-inverting inputs of these comparators. The inverting inputs can be wired to adjustable reference voltages with threshold limits increasing from zero on up. The outputs of the comparators 510 are connected to a multiplexer 55. The output of the multiplexer, together with the pixel clock signal 52, goes to the address counter 54 through an AND-gate 53. The output of the address counter is connected to the address line A_a of the random access memory (RAM) 56 as well as to the multiplexer 55. The data output A_{do} of the random access memory 56 is connected to an adder 57, whose output is redirected to the data input A_{di} of the random access memory 56. The data in block B of the random access memory 56 are transferable from block B to the microcomputer 4 by relaying the B-addresses through the data output. The reset inputs to address counter 54 and random access memory 55 as well as the control input IRQ to interrupt the program of the microcomputer 4 are tied to the row-synchronization pulse 60 of the television camera 1. Input 41 to select the two blocks A and B of the random access memory 56 also leads back to the row-synchronization pulse 60 through a flip-flop 58. A reversing circuit 62, which enables the detection of a decrease in brightness, is connected to the last of the comparators and

2946561
R. 5876

to the multiplexer 55. The same reset signal as that for the address counter 54 and random access memory 56 is provided by the row-synchronization pulse 60 to this reversing circuit 62.

As the first row of the television screen is started, all memory locations in random access memory 56 are reset, as is the flip-flop 58. The RAM has two blocks, 0 and 1, whose memory locations are separately addressable using the address lines A_a and B_a. Address A is assigned to block 0 and address B is assigned to block 1. Address A, which has the value 0 prior to the first pixel impulse, is simultaneously present at the multiplexer 55 and connects the output of comparator 510 having the smallest threshold limit. The adder 57 raises the content of the A0 memory cell by 1 at every pixel pulse signal and thus counts the number of pixels. As long as the video signal is smaller than the threshold limit at the reference input of the comparator 510, this counting process continues. If, however, the amplitude of the video signal exceeds this threshold limit, the associated comparator 510 is tripped and passes on to the address counter 54 through the multiplexer 55 and through the AND-gate 53 at the next incoming pixel impulse signal 52, raising the state of the counter by 1. This new address is then switched through to the RAM as well and the results of the adder is written to the (A1) memory cell. Counting the pixels then continues at the new A1 address. The value present in the previous A0 memory cell corresponds to the number of pixels reached up to that point. The new address is also simultaneously present at the multiplexer 55, which then connects the output of the next comparator. If the video signal exceeds the threshold limit of the next comparator, the process described above repeats itself. After the last comparator is tripped, the individual memory cells contain the number of pixels of the video signal progressing from the beginning of the row until the next highest threshold limit is exceeded. At the beginning of the next row, the flip-fop 58 is reversed by the row-synchronization pulse 60, an interrupt signal is sent to the input IRQ of the microcomputer 4 and the address counter 54 is erased. By tripping the flip-flop 58, the polarity changes at the block-select input 41. The assignment of memory blocks 0 and 1 to the addresses is thus interchanged. Address A then goes to block 1 and address B goes to block 0, i.e., the values stored while processing the first row in block 0 can be read out by the microcomputer 4 at its slow working speed while the second row is being processed. The memory block 1 assigned to address A is erased at the beginning of the row and is then ready to count and store the pixels of the second row.

The processes of detecting and reading values continue up until the last row of the screen. The memory of the microcomputer 4 then contains a table of all detected pixels of all rows of the television signal.

It is also possible to detect decreasing brightness using the dashed addition in Figure 2. A reversing circuit is triggered by the last comparator n, which changes the assignment of the addresses to the comparators 510 and reverses the output polarity of the multiplexer 55. The recording of the pixels for decreasing brightness is done analogous to the above-described process. The only difference is that the random access memory 56 now has twice the number of memory locations for this purpose.

2946561
R. 5876

10-29-1979 St/W1

ROBERT BOSCH GMBH, 7000 Stuttgart 1

An apparatus to automatically check the light distribution of an automobile headlight

Summary

An apparatus to automatically check the headlights of automobiles is suggested which automatically positions the light distribution of the headlight, in particular the high-beam maximum, the light-darkness boundary and its geometrical shape, onto a projection screen using a television measuring system with a microcomputer-controlled video signal evaluation system. This apparatus also displays this positioning on a monitor and stores the information. Stepper motors tilt the headlight along with its light-darkness boundary into prescribed positions at which the actual measurements of photometric characteristics of the headlight are taken. These are detected, evaluated in the microcomputer and finally printed.

2946561
R. 5876

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2946561
R. 5876

Figure 2

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"Apparatus to automatically check the light distribution of an automobile headlight"

2946561
R. 5876

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Fig. 1

1/2

Robert Bosch GmbH, 7000 Stuttgart 1, November 16, 1979 application

"Apparatus to automatically check the light distribution of an automobile headlight"

CERTIFICATION

I, Jeffrey Nadeau , hereby declare that I am a professional translator experienced in translating patents and technical publications, and that the foregoing is a true and accurate translation of German Patent 29 46 561 A1, to the best of my knowledge.

JEFFREY NADEAU

4/16/99